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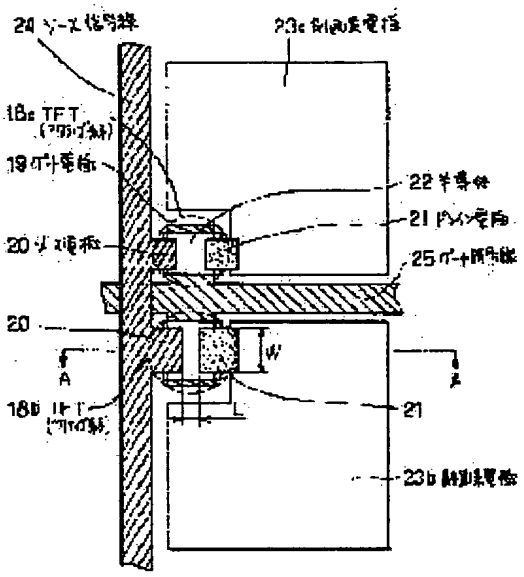
OKITA HIKARI

(54) LIQUID CRYSTAL DISPLAY ELEMENT

(57)Abstract:
PURPOSE: To improve the visual angle characteristics of a liquid crystal display element without excessively forming insulating films and additive capacitor electrodes in superposition.
CONSTITUTION: This liquid crystal display element is constituted by disposing plural pixel electrodes for impressing voltages to drive liquid crystals, signal wirings and active elements 18a, 18b having charging ability on at last one transparent substrate of two sheets of transparent substrates which are arranged to face each other and close the liquid crystals and disposing counter electrodes for impressing voltages to drive the liquid crystals on the other transparent substrate. The individual pixel electrodes are divided into plural sub-pixel electrodes 23a, 23b and at least one of the active elements 18a, 18b varying in the charging ability are installed to the respective sub-pixel electrodes. The individual counter electrodes facing the individual pixel electrodes are divided into the plural sub-counter electrodes having regions of different area ratios and the different voltages are impressed to the individual sub-counter electrodes.



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CLAIMS

[Claim(s)]
[Claim 1]It has an active element which provides at least two or more picture element electrodes which impress voltage which drives said liquid crystal on a transparent substrate of a method of - among transparent substrates of two sheets which make it counter mutually, arrange and blockade a liquid crystal, connects with this each picture element electrode with signal wiring, and has charging capacity, In a liquid crystal display element which provided a counterelectrode which impresses voltage which drives said liquid crystal on a transparent substrate of another side, A liquid crystal display element installing said at least one active element which divides said each picture element electrode into two or more sub-picture element electrodes, and from which charging capacity differs in this each sub-picture element electrode, respectively.
[Claim 2]It has an active element which provides at least two or more picture element electrodes which impress voltage which drives said liquid crystal on a transparent substrate of a method of - among transparent substrates of two sheets which make it counter mutually, arrange and blockade a liquid crystal, connects with this each picture element electrode with signal wiring, and has charging capacity, In a liquid crystal display element which provided a counterelectrode which impresses voltage which drives said liquid crystal on a transparent substrate of another side, A liquid crystal display element impressing voltage which divides into two or more subcounterelectrodes which have a field where surface ratio differs said counterelectrode of each which counters said each picture element electrode, and is different in this each subcounterelectrode.
[Claim 3]A liquid crystal display element impressing voltage which divides into two or more subcounterelectrodes which have a field where surface ratio differs said counterelectrode of each which counters said picture element electrode of further each in the liquid crystal display element according to claim 1, and is different in this each subcounterelectrode.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to the liquid crystal display element of a wide viewing angle display.
[0002]
[Description of the Prior Art]In this kind of liquid crystal display element, the following composition is conventionally adopted as the transparent substrate side which forms a picture element electrode among the transparent electrodes of two sheets which were made to counter JP,4-348324,A mutually like an indication, and have been arranged. That is, 1 pixel was divided into two or more sub-picture element electrodes, and the control capacitor electrode was provided via the 1st insulator layer under the picture element electrode, and the additional capacitor electrode is further provided via the 2nd insulator layer on the picture element

electrode.
[0003]
[Problem(s) to be Solved by the Invention]If shown in the above-mentioned conventional liquid crystal display element, the voltage-transmissivity characteristic (it is hereafter called the V-T characteristic) of the sub-picture element electrode divided by setting up freely the capacity of the control capacitor electrode provided via the insulator layer up and down and an additional capacitor electrode is controlled. Thereby, into 1 pixel, two or more fields where the V-T characteristics differ are formed, and the design flexibility of the whole pixel is raised.
[0004]This is giving the different V-T characteristic for every divided sub-picture element electrode, would form selectively the field saturated in the pixel which is carrying out the halftone display, and will have improved the visual angle characteristic of a halftone display by this. However, since the additional capacitor electrode was further provided via the insulator layer after the general composition of providing a control capacitor electrode via an insulator layer under a picture element electrode as it is a liquid crystal display element of this composition, the poor still newer defects generated conventionally increased in number. That is, this poor mode is a defect of a point defect or a line defect by short circuit with an additional capacitor electrode, a picture element electrode, a counterelectrode, a gate electrode, a source electrode, a thin film transistor (hereafter referred to as TFT), etc., and the problem that the reliability as a liquid crystal display element was inferior by this generated it.
[0005]The problem that foreign matter adhesion and poor membrane formation increased on a picture element electrode by the complicated composition of carrying out superposition formation of an insulator layer and the additional capacitor electrode too much being taken was also generated. Then, it is made in order that this invention may solve the above-mentioned problem, and it aims at raising the visual angle characteristic of a liquid crystal display element, without carrying out superposition formation of an insulator layer and the additional capacitor electrode too much.
[0006]
[Means for Solving the Problem]Inside of a transparent substrate of two sheets which makes this invention counter mutually to achieve the above objects, arranges, and blockades a liquid crystal, It has an active element which provides at least two or more picture element electrodes which impress voltage which drives said liquid crystal on a transparent substrate of a method of -, connects with this each picture element electrode with signal wiring, and has charging capacity, In a liquid crystal display element which provided a counterelectrode which impresses voltage which drives said liquid crystal on a transparent substrate of another side, Said each picture element electrode is divided into two or more sub-picture element electrodes, and technical means of installing said at least one active element from which charging capacity differs in this each sub-picture element electrode, respectively are adopted.
[0007]It divides into two or more subcounterelectrodes which have a field where surface ratio differs said counterelectrode of each which counters said each picture element electrode, and may be made to impress voltage which is different in this each subcounterelectrode.
[0008]
[Function]In this invention, the active element which divides each picture element electrode into two or more sub-picture element electrodes and from which charging capacity differs in this sub-picture element electrode was provided.
Therefore, two or more sub-picture element electrodes will have a different voltage-transmissivity characteristic, respectively.
Since voltage which divides into two or more subcounterelectrodes which have a field where surface ratio differs the counterelectrode which counters each picture element electrode, and is different in each was impressed, each picture element electrode will have a field where voltage-transmissivity characteristics differ.
[0009]
[Example]
(The 1st example) This invention is explained according to the 1st example shown in a figure below. Drawing 2 is an A-A sectional view of drawing 1 in which the important section flat

surface of the liquid crystal display element of the 1st example is shown. The liquid crystal display element 1 blockades the liquid crystal layer 4 in the gap of the transparent substrates 2 and 3 which consist of glass of two sheets which was made to counter mutually and has been arranged, and takes the composition which pasted together the lower polarizing plate 5 and the upper polarizing plate 6 further. Form here the gate electrode 7 which turns into the transparent electrode 2 from Cr, and two or more picture element electrodes 9 which consist of ITO(s) (indium stannic acid ghost) via the insulator layer 8 which consists of SiNx(es) are formed, The semiconductor 12 which consists of the source electrode 10 and the drain electrode 11 which consist of Ti, and a-Si is formed. And the orienting film 13 is formed so that these picture element electrode 9 grades formed and obtained may be covered thoroughly. The filter 15 for light transmission which colors it the black mask 14 for protection from light and the three primary colors (R, G, B) which become a method of - and the transparent electrode 3 from Cr which constitutes a matrix, and serves as a light filter is formed. And the orienting film 17 is formed and it is so that the counterelectrode 16 which consists of ITO(s) (indium stannic acid ghost) similarly may be formed and each may be covered thoroughly.

[0010]The thing completely same with the composition which can usually be considered by the material which can usually be considered is possible for the liquid crystal display element which consists of such composition enough. Now, the important section flat surface in the liquid crystal display element 1 of such composition is shown in drawing 1. However, drawing 1 is an important section top view showing - pixel of the transparent substrate 2 which formed the picture element electrode 9 shown in drawing 2, and shows the easiest example.

[0011]In drawing 1, TFT18a and TFT18b comprise the semiconductor 22 which consists of the source electrode 20 and the drain electrode 21 which consist of the gate electrode 19 which consists of Cr(s), and Ti as an active element which has charging capacity, and a-Si, and have reverse stagger structure generally known. Charging capacity shall differ TFT18a and TFT18b, respectively by changing channel width W and channel length L of the source electrode 20 and the drain electrode 21 intentionally, respectively. This time, channel width W of TFT18a was made small, channel length L was enlarged, and charging capacity of TFT18a was made less [than TFT18b] than TFT18b. And it divided into two so that surface ratio might be set to 1:1 at the sub-picture element electrodes 23a and 23b of the sliding direction which shows 1 pixel in a figure, and TFT18a was provided in the sub-picture element electrode 23a, and TFT18b was provided in the sub-picture element electrode 23b. Thus, the signal from the IC circuit of the external connection which is not illustrated is received, and TFT18a and 18b are made to turn on and turn off by allocating the gate signal line 25 which consists of the source signal line 24 set to provided TFT18a and TFT18b from Ti, and Cr.

[0012]The feature of the 1st example in such composition divides a 1-pixel picture element electrode into two sub-picture element electrodes, and there is in having provided active elements, such as TFT from which providing TFT from which channel width W and channel length L differ in each sub-picture element electrode, i.e., charging capacity, differs. However, in order that the 1st example might deepen an understanding, the easiest example was only indicated, there is no necessity of not necessarily carrying out the 1-pixel number of partitions comparatively for 2 minutes, it is infinitely possible and an effect also goes up. However, since TFT will also increase and a pixel area will become small in proportion to this if the number of partitions increases, it is necessary to take the effective number of partitions into consideration enough. therefore -- practically -- desirable -- per pixel -- two division - carrying out comparatively for 5 minutes is appropriate. There is no necessity of defending stubbornly to 1:1 like [area / of the sub-picture element electrode after division] the 1st example, and it can constitute infinitely.

[0013]Next, this invention persons analyzed and evaluated the V-T characteristic by the measuring method which shows drawing 4 the liquid crystal display element shown in drawing 3 in order to know the visual angle characteristic in the liquid crystal display element of the above composition. Drawing 3 is the perspective view of the liquid crystal display element of the 1st example which divided the picture element electrode into two so that surface ratio might be set to 1:1.

It pastes together so that the TFT substrate rubbing direction 27 and the upper polarizing plate extinction axis 28 may carry out TFT substrate 26 and the upper polarizing plate 29 in which TFT which is not illustrated was formed in - **, Having pasted together so that the filter base board rubbing direction 31 and the lower polarizing plate extinction axis 32 might carry out the filter base board 30 and the lower polarizing plate 33 in which the filter was formed in - ** is shown.

That is, the upper polarizing plate 29 and the lower polarizing plate 33 are in NW (normally white) mode, i.e., the liquid crystal display element which made the extinction axis cross and was pasted together so that it might become a white display in the state of impressing no voltage.

[0014]The measuring method of the V-T characteristic was enforced by the method shown in drawing 4. That is, altitude above was used as the transverse plane from the upper polarizing plate 35 side of the liquid crystal display element 34, and it was begun from this front direction to measure the V-T characteristic, and carried out by changing a measuring point (arrow direction of a figure) gradually downward (the direction of theta of a figure). The result obtained by the above measuring methods was as follows.

[0015]In order to analyze and evaluate [1st] the liquid crystal display element of drawing 3 first, when a picture element electrode was not divided and TFT fully had charging capacity to a picture element electrode, channel width W is large and channel length L measured about the V-T characteristic of the liquid crystal display element in the case of being small (not shown). The measuring point considered it as theta= 0 times (namely, transverse plane), 10 degrees, 20 degrees, 30 degrees, 40 degrees, and 50 degrees, and the result surveyed and obtained about each was shown in drawing 5. The horizontal axis in drawing 5 is the impressed electromotive force to a picture element electrode, and a vertical axis is relative transmittance when front (equivalent to theta= 0 measuring point) maximum transmittances are made into 100%. according to drawing 5, especially, when a measuring point is made into theta= 50 degrees, although it is remarkable, impressed electromotive force increases gradually from 0V to 6V, for example -- it was alike and followed, and the abbreviated 1.5V neighborhood to relative transmittance began to decrease rapidly, and has reached in the abbreviated 2.5V neighborhood at - ** A point (equivalent to relative transmittance and abbreviated 10%). However, relative transmittance is decreasing gently as the phenomenon which relative transmittance increases will appear, it will reach in the abbreviated 3.4V neighborhood till a B point (equivalent to relative transmittance and abbreviated 18%) and impressed electromotive force will increase after that, if impressed electromotive force increases further. Thus, the phenomenon of increasing after relative transmittance carries out - degree reduction as impressed electromotive force increases, and decreasing further again is the cause of reversal of the bright display of a liquid crystal display element, and a dark display, and is a reason said for a down viewing angle range to be narrow.

[0016]Here, especially in this example, this phenomenon will be called a "swelling phenomenon." It turns out that such a swelling phenomenon becomes large as a measuring point begins to appear clearly from theta= 30 degrees about in drawing 5 and a measuring point becomes down (namely, theta= 40 degrees, 50 degrees).

[0017]On the other hand, to a picture element electrode, when insufficient, channel width W is [the charging capacity of TFT] small [2nd], and channel length L analyzed about the V-T characteristic in the case of being large. The V-T characteristic in this case is easily calculable from the expression 1, 2, 3, 4, 5, and 6 which is an actual measurement of drawing 5, and a general formula of an electrical property.

[0018]

[Equation 1]

$I_D=-\text{beta}\ (V_D-V_s)\ \{2(V_G-V_T)-(V_D+V_s)\}$

I_D : Drain current, V_s: Source voltage, threshold characteristics of V_G:gate voltage V_T:TFT [0019]

[Equation 2]beta=(W/L) $C_i$mu/2W: Channel width, L:channel length, gate-dielectric-film capacity per C_i:unit area, mu:mobility [0020]

[Equation 3]$I_D=C_t dV_D/dt$ [0021]

[Equation 4]$C_t=C_{LC}+C_s+C_{GD}C_{LC}$: Volume capacity, C_s:storage capacitance, a C_{GD}:gate - the capacity between drains [0022]

[Equation 5]

$$V_D = V_s - \frac{2(V_G - V_T - V_s)(V_s - V_0)P}{2(V_G - V_T - V_s) + (V_s + V_0)(1-P)}$$

V_O: Initial drain voltage [0023]

[Equation 6]

$P=\exp\{-(2\ \text{beta}/C_t)(V_G-V_T-V_s)\ t\}$

t: gate ON time -- the V-T characteristic result which carried out the simulation from the expression 1, 2, 3, 4, 5, and 6 of these is shown in drawing 6.

[0024]According to drawing 6, in the impressed electromotive force 0V-6V, it turns out that a measuring point swells at theta= 30 degrees and 40 degrees, and there is almost no phenomenon. Although relative transmittance begins to decrease rapidly from the abbreviated 1.5V neighborhood like drawing 5 in theta= 50 degrees, It turns out that some swelling phenomenon which is given to a - ** A' point (equivalent to relative transmittance and abbreviated 10%) in the abbreviated 3.4V neighborhood, and is attained to B' point (equivalent to relative transmittance and abbreviated 18%) in the abbreviated 5.7V neighborhood appears.

[0025]Based on the analysis result of above drawing 5 and drawing 6, both V-T characteristic was shown in drawing 7 about the case where a measuring point is theta= 50 degrees especially as a representative, and comparison and examination were performed. The charging capacity of TFT comes out enough to a picture element electrode, and this is the comparison in a certain case and the case of being insufficient, and examination. In drawing 7, the dashed line 36 is the V-T characteristic shown in drawing 5 when the charging capacity to a picture element electrode is enough, and the - dotted line 37 is the V-T characteristic shown in drawing 6 when the charging capacity to a picture element electrode is insufficient. It turns out here that the A point of the dashed line 36 and the B point (equivalent to the A point of drawing 5 and a B point) are moving to A'point and B' point (equivalent to A'point and B' point of drawing 6) of the - dotted line 37. If such both V-T characteristic is mixed, it will become like the solid line 38, and a swelling phenomenon is almost deterred, and ** is known. This will become equivalent to TFT18a from which charging capacity differs in the sub-picture element electrodes 23a and 23b which divided 1 pixel into two like drawing 1, and the V-T characteristic produced by providing 18b.

[0026]Then, in order to check whether the V-T characteristic of the liquid crystal display element of the composition of drawing 1 actually becomes like the solid line 38 of drawing 7 in several different measuring points based on the above-mentioned analysis result to the 3rd, this V-T characteristic was surveyed to it, and it was shown in drawing 8. Drawing 8 is the V-T characteristic of the 1st example in case measuring points are theta= 30 degrees, 40 degrees, and 50 degrees.

It turns out that it swells in every measuring point and the phenomenon is reduced enough certainly.

[0027]Since a viewing angle range swells from a front direction to theta= 50 degrees to down at least and a phenomenon is certainly suppressed if shown in the liquid crystal display element of the above composition and the V-T characteristic, the liquid crystal display element whose visual angle characteristic is sufficiently satisfying is obtained. This invention persons checked that it was effective to theta= 60 degrees as a range which can deter a swelling phenomenon by the same V-T characteristic analysis.

[0028]Since there is no necessity of taking the complicated composition of carrying out superposition formation of an insulator layer and the additional capacitor electrode too much, on a picture element electrode, a reliable liquid crystal display element is obtained without foreign

matter adhesion, poor membrane formation, a point defect, and a poor line defect increasing. Although the case where one TFT per sub-picture element electrode was used as an active element which has charging capacity was explained in full detail in the 1st example, the same effect is acquired even if it uses two or more TFT(s). Even if it uses MIM (Metal-Insulator-Metal) as an active element, it is possible to completely acquire the same effect.

[0029]Although the liquid crystal display element in NW (normally white) mode was explained in full detail in the 1st example, even if it is in NB (normally black) mode, i.e., the mode which show a black display in the state of impressing no voltage, it is possible to completely acquire the same effect.

(The 2nd example) Although division of the picture element electrode in the transparent substrate which forms TFT was explained in full detail in the 1st example, since the same effect is acquired even if it is a transparent electrode side of another side which counters this picture element electrode, according to a figure, it explains below.

[0030]Drawing 9 is an important section top view of the liquid crystal display element of the 2nd example. This is divided into three of the subcounterelectrodes 40a, 40b, and 40c which has the field alpha, beta, and gamma where area differs mutually the counterelectrode 40 which counters the 1-pixel picture element electrode 39 which has TFT41, for example, By impressing voltage which is different in each, the completely same effect as the 1st example is made profitably like.

[0031]Although drawing 10 is a B-B sectional view of drawing 9, since it is the same composition as the liquid crystal display element shown in drawing 2 of the 1st example, explanation is omitted. However, the light leak prevention from between the subcounterelectrodes 40a, 40b, and 40c is attained by forming the black mask 43 between each. 44 -- as for a picture element electrode and 49, an upper polarizing plate, and 46 and 47 are [an orienting film and 52] liquid crystal layers a filter, and 50 and 51 a transparent electrode and 48 a lower polarizing plate and 45.

[0032]Here, the effective voltage impressed to the liquid crystal layer 52 serves as the sum of the impressed electromotive force to the subcounterelectrodes 40a, 40b, and 40c, and the picture element voltage supplied to the picture element electrode 39 from the source signal line 42 via TFT41. Now, since analysis and evaluation were tried with the completely same measuring method as the 1st example, the V-T characteristic of the liquid crystal display element of such composition is explained according to a figure below.

[0033]It measured about the V-T characteristic at the time of setting impressed electromotive force to this counterelectrode to 1.5V in the counterelectrode before dividing into a subcounterelectrode the 1st first. The measuring point considered it as theta= 0 times (namely, transverse plane), 10 degrees, 20 degrees, 30 degrees, 40 degrees, and 50 degrees, and the result surveyed and obtained about each was shown in drawing 11. The vertical axis in drawing 11 shows relative transmittance when the maximum transmittances in a transverse plane are made into 100%, and a horizontal axis shows picture element voltage. According to drawing 11, it turns out that a swelling phenomenon becomes large as a measuring point begins to appear from theta= 30 degrees about and a measuring point becomes down (theta= 40 degrees, 50 degrees) like drawing 5 of the 1st example.

[0034]On the other hand, the result of having measured the V-T characteristic at the time of setting impressed electromotive force to this counterelectrode to 0.5V, 1.0V, and 1.5V in the counterelectrode before dividing into a subcounterelectrode the 2nd about theta= 40 measuring points especially as a representative is shown in drawing 12. According to drawing 12, it turns out that 0.5v of parts with small impressed electromotive force have shifted the V-T characteristic of 0.5V and 1.0V rightward [of an every figure] as compared with the V-T characteristic that the impressed electromotive force to a counterelectrode is 1.5V (a swelling phenomenon.).

[0035]Next, to the 3rd, the V-T characteristic in the case of the 2nd example that uses the counterelectrode 40 to the 1-pixel picture element electrode 39 as shown in drawing 9 as the three subcounterelectrodes 40a, 40b, and 40c was analyzed and evaluated based on these results, and it was shown in drawing 13. At this time, the field which the subcounterelectrodes 40a, 40b, and 40c and the picture element electrode 39 overlap was made into the field alpha,

the field beta, and the field gamma, respectively, and surface ratio of each field was made into 7%, 21%, and 72%. And the voltage of 0.5V, 1.0V, and 1.5V was impressed to the subcounterelectrodes 40a, 40b, and 40c, respectively. according to drawing 13 -- the V-T characteristic of the three fields alpha, beta, and gamma -- drawing 12 -- the same -- 0.5 -- it shifts rightward [of a figure] every [V] and it turns out that the relative transmittance in the part and the picture element voltage 0V from which the surface ratio of the field alpha, beta, and gamma differs further also differs proportionally. Here, it can be said that the V-T characteristic like [since the area of the picture element electrode 39 is equal to total of the area of the field alpha, beta, and gamma] the solid line 53 used as mixing of the field alpha, beta, and gamma is the V-T characteristic of the picture element electrode 39 as it is. The solid line 53, i.e., the V-T characteristic of the picture element electrode 39, is understood that the swelling phenomenon is clearly lost as compared with the V-T characteristic in theta= 40 measuring points as shown in drawing 11 or drawing 12.

[0036]Then, in order to check whether the V-T characteristic of the liquid crystal display element of the composition of drawing 9 actually becomes like the solid line 53 of drawing 13 in several different measuring points based on the above-mentioned analysis result to the 4th, this V-T characteristic was surveyed to it, and it was shown in drawing 14. Drawing 14 is the V-T characteristic of the 2nd example in the case where a measuring point considers it as theta= 0 times (namely, transverse plane), 10 degrees, 20 degrees, 30 degrees, 40 degrees, and 50 degrees. According to drawing 14, it was checked that the completely same effect as the 1st example had been acquired with swelling even if it changes the measuring point theta from a transverse plane to 50 degrees at least, and a phenomenon not appearing at all. This invention persons checked that it was effective to theta= 60 degrees as a range which can deter a swelling phenomenon by the same V-T characteristic analysis.

[0037]Even if it is a liquid crystal display element of composition of that the above result divides the counterelectrode to one picture element electrode into three subcounterelectrodes, the completely same effect as the 1st example will be acquired. Although the 2nd example showed the example which divided into three subcounterelectrodes the counterelectrode which counters each picture element electrode, Even if it impresses voltage which does not need to defend stubbornly to trichotomy, divides into two or more subcounterelectrodes, and is different in each subcounterelectrode, it cannot be overemphasized that the completely same effect as the 2nd example is acquired.

[0038]Even if it mixes both the composition shown in the 1st example, and composition of being shown in the 2nd example, it is satisfactory at all.

[0039]

[Effect of the Invention]Since the active element which divides each picture element electrode into two or more sub-picture element electrodes and from which charging capacity differs in this sub-picture element electrode in claim 1 was provided if it was in this invention as stated above, The outstanding effect that the visual angle characteristic of a liquid crystal display element can be raised is done so, without carrying out superposition formation of an insulator layer and the additional capacitor electrode too much.

[0040]In claim 2, since voltage which divides into two or more subcounterelectrodes which have a field where surface ratio differs a counterelectrode, and is different in each subcounterelectrode was impressed, the same outstanding effect as the above is done so. In claim 3, since claim 1 and this invention according to claim 2 were annexed, the same outstanding effect as the above is acquired.

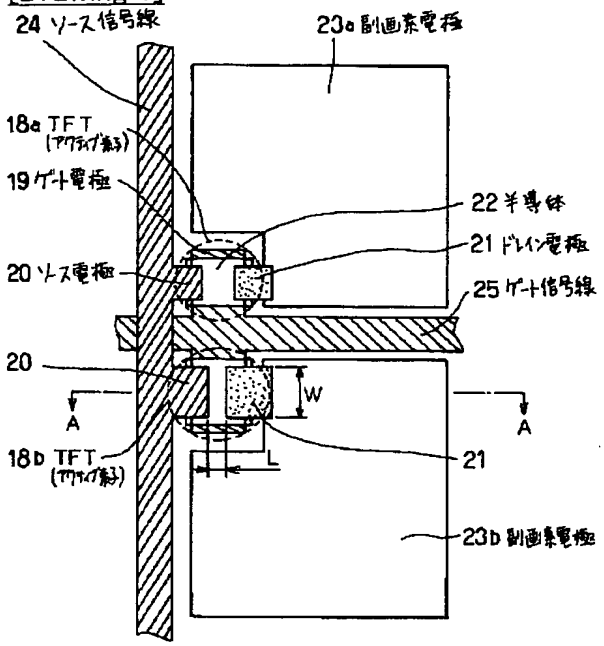
[Translation done.]

DESCRIPTION OF DRAWINGS

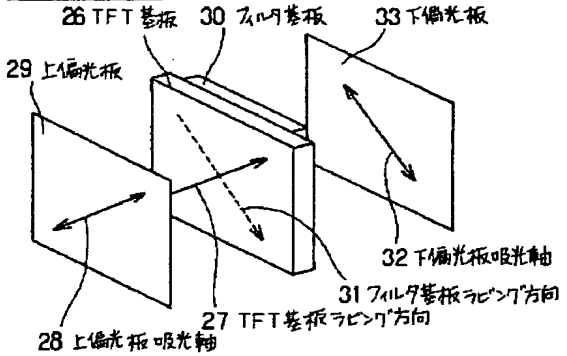
[Brief Description of the Drawings]
[Drawing 1]It is an important section flat-surface part which shows - pixel of the transparent substrate which provided the sub-picture element electrode of this invention.
[Drawing 2]It is an A-A sectional view of drawing 1.
[Drawing 3]It is a perspective view of the liquid crystal display element of this invention.
[Drawing 4]The measuring method of the V-T characteristic of this invention is shown.
[Drawing 5]A picture element electrode is not divided and the charging capacity of TFT shows the V-T characteristic of sufficient liquid crystal display element.
[Drawing 6]A picture element electrode is not divided and the V-T characteristic of a liquid crystal display element with insufficient charging capacity of TFT is shown.
[Drawing 7]The V-T characteristic in case a measuring point is theta= 50 degrees is shown.
[Drawing 8]The V-T characteristic in the measuring point from which this invention differs is shown.
[Drawing 9]The important section flat surface of the liquid crystal display element of other examples of this invention is shown.
[Drawing 10]It is a B-B sectional view of drawing 9.
[Drawing 11]The V-T characteristic in the measuring point from which the counterelectrode before dividing into a subcounterelectrode differs is shown.
[Drawing 12]The V-T characteristic in theta= 40 measuring points of the counterelectrode before dividing into a subcounterelectrode is shown.
[Drawing 13]The V-T characteristic in three fields of other examples of this invention is shown.
[Drawing 14]The V-T characteristic in the measuring point from which other examples of this invention differ is shown.
[Description of Notations]
9, 39, and 48 Picture element electrode
18a, 18b, 41 TFT (active element)
23a and 23b Sub-picture element electrode
16 and 40 Counterelectrode
40a, 40b, and 40c Subcounterelectrode

DRAWINGS

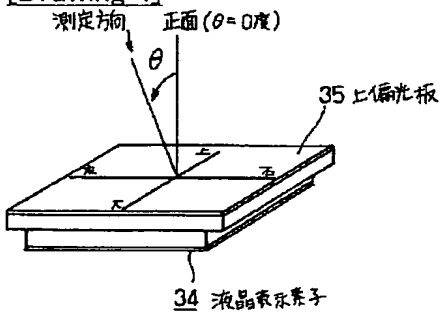
[Drawing 1]



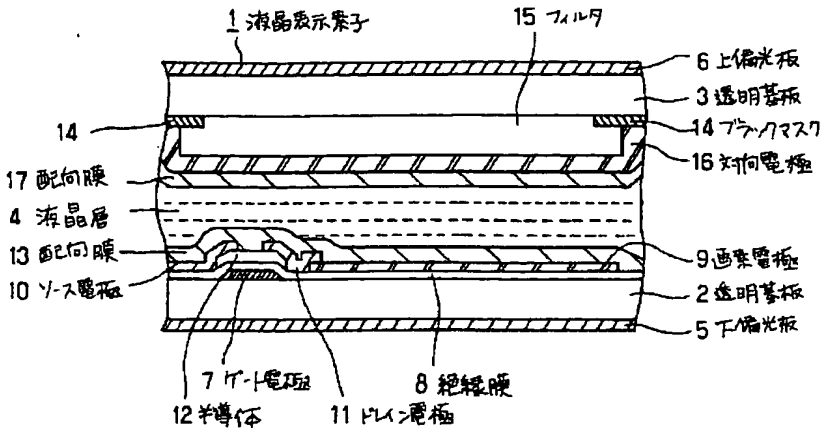
[Drawing 3]



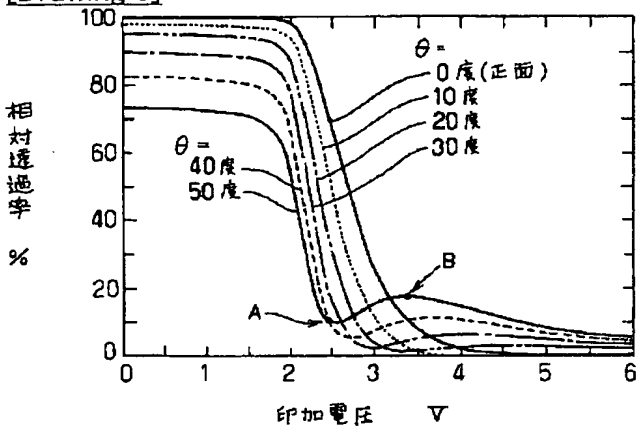
[Drawing 4]



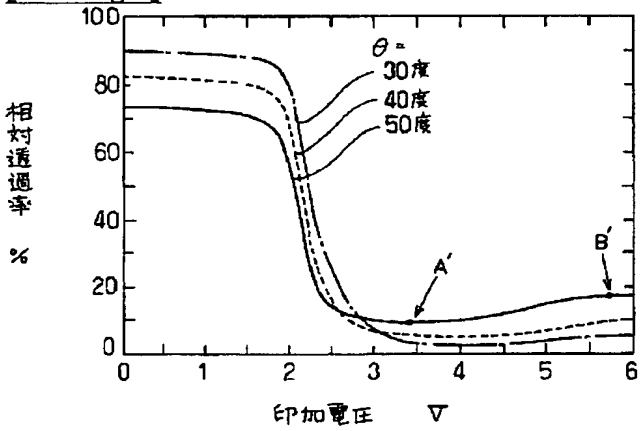
[Drawing 2]



[Drawing 5]



[Drawing 6]



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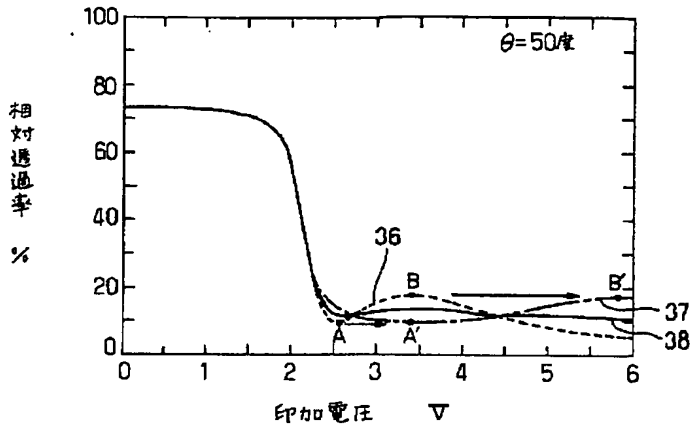

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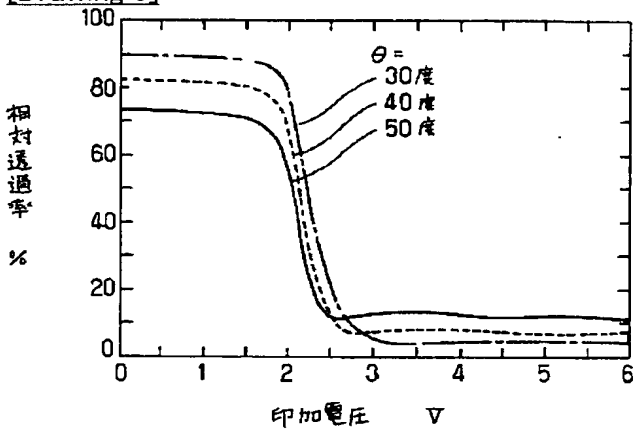

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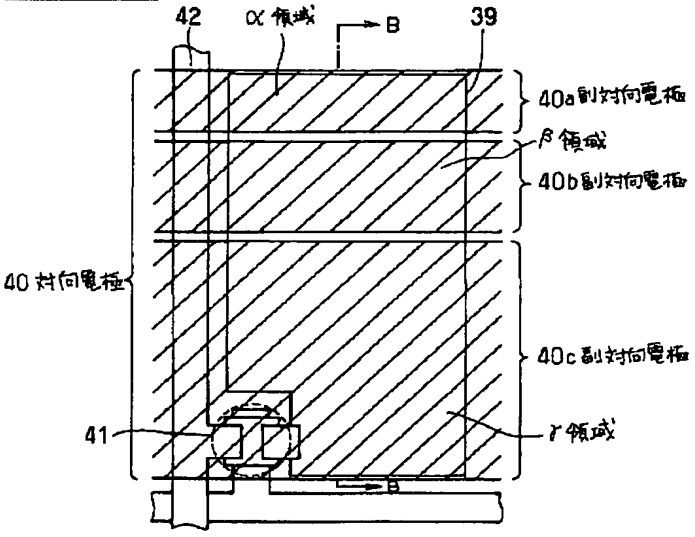

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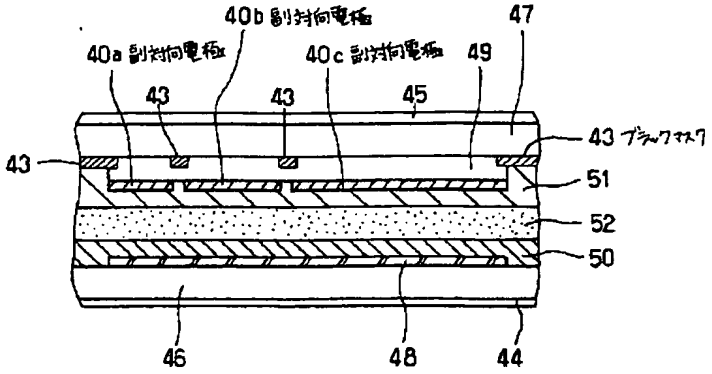

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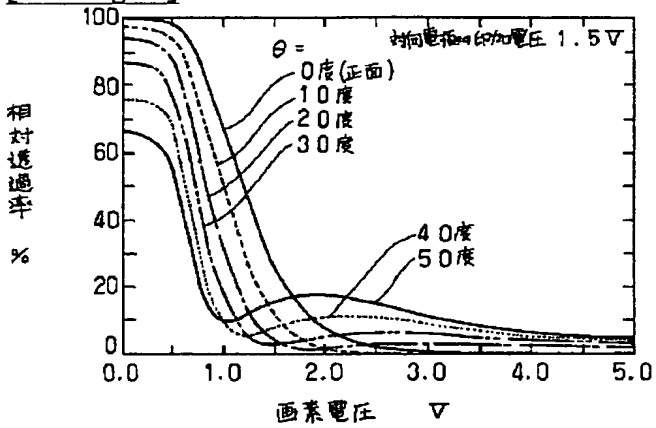

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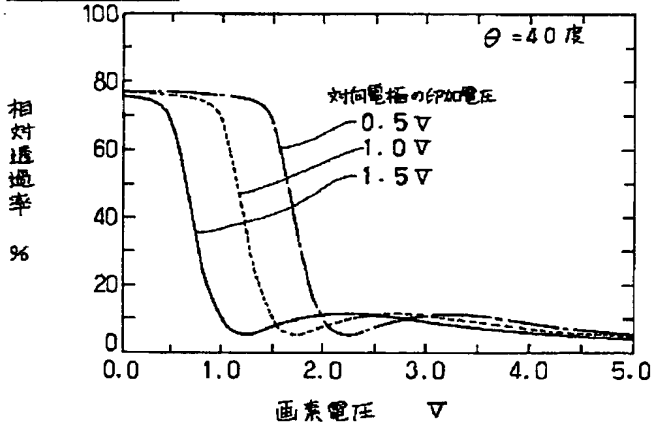

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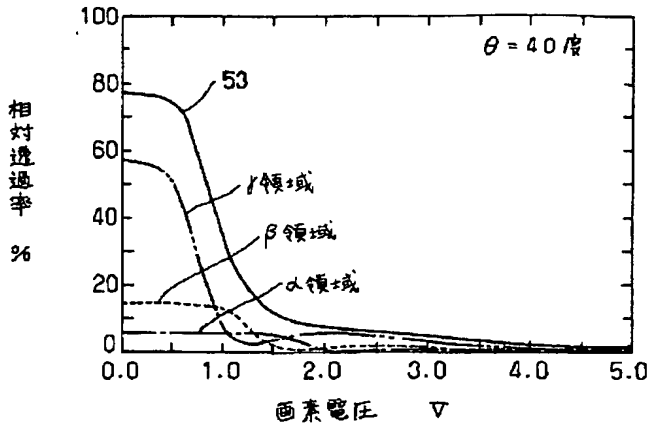

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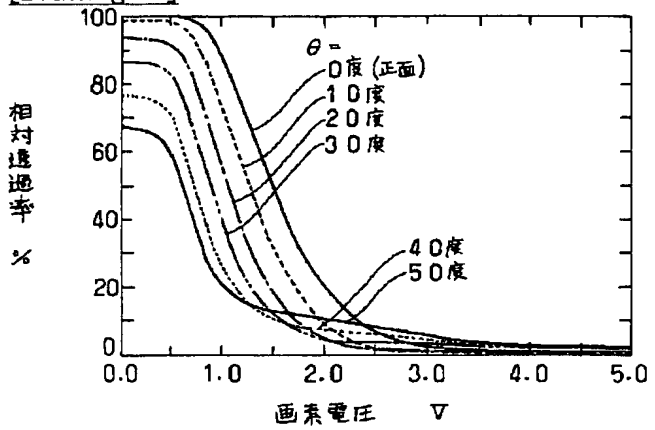

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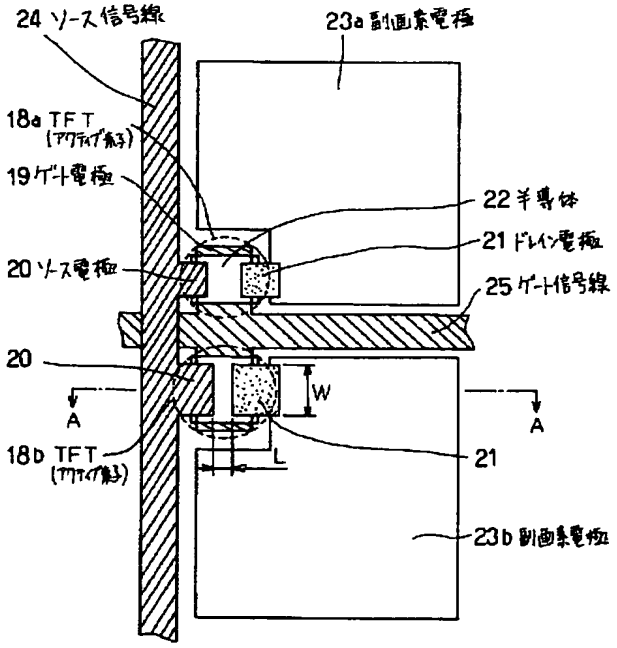
(54)【発明の名称】　液晶表示素子

(57)【要約】

【目的】　絶縁膜と付加コンデンサ電極を余分に重畳形成することなく、液晶表示素子の視角特性を向上させる。

【構成】　互いに対向させ配置し液晶を閉塞する２枚の透明基板のうち、少なくとも一方の透明基板上に液晶を駆動する電圧を印加する複数の画素電極と信号配線と充電の能力を有するアクティブ素子１８ａ、１８ｂを設け、他方の透明基板上に液晶を駆動する電圧を印加する対向電極を設けた液晶表示素子において、個々の画素電極を複数の副画素電極２３ａ、２３ｂに分割してそれぞれに充電能力の異なるアクティブ素子１８ａ、１８ｂを少なくとも１つ設置する。および／または個々の画素電極に対向する個々の対向電極を面積比の異なる領域を有する複数の副対向電極に分割し、個々の副対向電極に異なる電圧を印加する。



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【特許請求の範囲】

【請求項１】　互いに対向させ配置し液晶を閉塞する２枚の透明基板のうち、少なくとも一方の透明基板上に前記液晶を駆動する電圧を印加する複数の画素電極を設け該各画素電極には信号配線と接続して充電能力を有するアクティブ素子を備え、他方の透明基板上に前記液晶を駆動する電圧を印加する対向電極を設けた液晶表示素子において、

個々の前記画素電極を複数の副画素電極に分割し、個々の該副画素電極にそれぞれ充電能力の異なる前記アクティブ素子を少なくとも１つ設置することを特徴とする液晶表示素子。

【請求項２】　互いに対向させ配置し液晶を閉塞する２枚の透明基板のうち、少なくとも一方の透明基板上に前記液晶を駆動する電圧を印加する複数の画素電極を設け該各画素電極には信号配線と接続して充電能力を有するアクティブ素子を備え、他方の透明基板上に前記液晶を駆動する電圧を印加する対向電極を設けた液晶表示素子において、

個々の前記画素電極に対向する個々の前記対向電極を面積比の異なる領域を有する複数の副対向電極に分割し、個々の該副対向電極に異なる電圧を印加することを特徴とする液晶表示素子。

【請求項３】　請求項１記載の液晶表示素子において、さらに個々の前記画素電極に対向する個々の前記対向電極を面積比の異なる領域を有する複数の副対向電極に分割し、個々の該副対向電極に異なる電圧を印加することを特徴とする液晶表示素子。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、広視野角表示の液晶表示素子に関するものである。

【０００２】

【従来の技術】従来この種の液晶表示素子においては、特開平４－３４８３２４号に開示のごとく、互いに対向させ配置した２枚の透明電極のうち、画素電極を形成する透明基板側に以下のような構成を採用している。即ち、１画素を複数の副画素電極に分割し、そして、画素電極の下には第１絶縁膜を介して制御コンデンサ電極を設け、さらに、画素電極の上には第２絶縁膜を介して付加コンデンサ電極を設けている。

【０００３】

【発明が解決しようとする課題】上記従来の液晶表示素子にあっては、上下に絶縁膜を介して設けた制御コンデンサ電極と付加コンデンサ電極の容量を自由に設定することにより分割した副画素電極の電圧－透過率特性（以下、Ｖ－Ｔ特性と呼ぶ）を制御している。これにより、１画素内にＶ－Ｔ特性の異なる領域を複数形成し、画素全体の設計自由度を高めている。

【０００４】これは、分割した副画素電極毎に異なるＶ－Ｔ特性を持たせることであり、中間調表示をしている画素内に飽和した領域を部分的に形成し、これにより、中間調表示の視角特性を改善していることになる。しかしながら、この構成の液晶表示素子であると、画素電極下に絶縁膜を介して制御コンデンサ電極を設けるという一般的な構成の上に、さらに絶縁膜を介して付加コンデンサ電極を設けているので、従来発生する不良に、さらに新たな不良が増加した。即ち、この不良モードは、付加コンデンサ電極と画素電極、対向電極、ゲート電極、ソース電極、薄膜トランジスタ（以下、ＴＦＴと呼ぶ）等とのショートによる点欠陥や線欠陥の不良であり、これにより液晶表示素子としての信頼性が劣るという問題が発生した。

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【０００５】さらに、画素電極上に余分に絶縁膜と付加コンデンサ電極を重畳形成するという複雑な構成を取らざるを得ないことで、異物付着や成膜不良も増加するという問題も発生した。そこで、本発明は上記問題を解決するためになされたものであり、絶縁膜と付加コンデンサ電極を余分に重畳形成することなく、液晶表示素子の視角特性を向上させることを目的とする。

【０００６】

【課題を解決するための手段】本発明は上記目的を達成するために、互いに対向させ配置し液晶を閉塞する２枚の透明基板のうち、少なくとも一方の透明基板上に前記液晶を駆動する電圧を印加する複数の画素電極を設け該各画素電極には信号配線と接続して充電能力を有するアクティブ素子を備え、他方の透明基板上に前記液晶を駆動する電圧を印加する対向電極を設けた液晶表示素子において、個々の前記画素電極を複数の副画素電極に分割し、個々の該副画素電極にそれぞれ充電能力の異なる前記アクティブ素子を少なくとも１つ設置するという技術的手段を採用するものである。

【０００７】さらに、個々の前記画素電極に対向する個々の前記対向電極を面積比の異なる領域を有する複数の副対向電極に分割し、個々の該副対向電極に異なる電圧を印加するようにしてもよい。

【０００８】

【作用】本発明によれば、個々の画素電極を複数の副画素電極に分割しこの副画素電極に充電能力の異なるアクティブ素子を設けたので、複数の副画素電極はそれぞれ異なる電圧－透過率特性を有することになる。また、個々の画素電極に対向する対向電極を面積比の異なる領域を有する複数の副対向電極に分割してそれぞれに異なる電圧を印加したので、個々の画素電極は電圧－透過率特性の異なる領域を有することになる。

【０００９】

【実施例】

（第１実施例）以下本発明を図に示す第１実施例に従って説明する。図２は、本第１実施例の液晶表示素子の要部平面を示す図１のＡ－Ａ断面図である。液晶表示素子

１は、互いに対向させ配置した２枚のガラスからなる透明基板２、３の間隙に液晶層４を閉塞し、さらに下偏光板５および上偏光板６を貼り合わせた構成を採るものである。ここで、透明電極２にはＣｒからなるゲート電極７を形成し、ＳｉＮｘからなる絶縁膜８を介してＩＴＯ（インジウム錫酸化物）からなる複数の画素電極９を形成し、さらに、Ｔｉからなるソース電極１０およびドレイン電極１１とａ－Ｓｉからなる半導体１２を形成している。そして、形成して得たこれらの画素電極９等を完全に覆うように配向膜１３を形成している。一方、透明電極３にはマトリクスを構成するＣｒからなる遮光用のブラックマスク１４と３原色（Ｒ，Ｇ，Ｂ）に着色してカラーフィルタとなる透光用のフィルタ１５を形成している。そして、同様にＩＴＯ（インジウム錫酸化物）からなる対向電極１６を設けてそれぞれを完全に覆うように配向膜１７を形成しいる。

【００１０】なお、このような構成からなる液晶表示素子は、通常考え得る材料を以て通常考え得る構成にて全く同様のものが十分可能である。さて、このような構成の液晶表示素子１における要部平面を図１に示す。ただし、図１は図２に示す画素電極９を設けた透明基板２の一画素を示す要部平面図であり、最も簡単な例を示している。

【００１１】図１において、ＴＦＴ１８ａとＴＦＴ１８ｂは充電能力を有するアクティブ素子として、Ｃｒからなるゲート電極１９とＴｉからなるソース電極２０およびドレイン電極２１とａ－Ｓｉからなる半導体２２とから構成され、一般的に知られている逆スタガー構造となっている。さらに、ソース電極２０とドレイン電極２１のチャネル幅Ｗおよびチャネル長Ｌをそれぞれ故意に変更することで、ＴＦＴ１８ａとＴＦＴ１８ｂをそれぞれ充電能力の異なるものとしている。今回は、ＴＦＴ１８ｂよりもＴＦＴ１８ａのチャネル幅Ｗを小さくしチャネル長Ｌを大きくして、ＴＦＴ１８ａの充電能力をＴＦＴ１８ｂよりも少なくした。そして、１画素を図に示す上下方向の副画素電極２３ａと２３ｂに面積比が１：１となるように２分割し、副画素電極２３ａにはＴＦＴ１８ａを設け副画素電極２３ｂにはＴＦＴ１８ｂを設けた。このようにして設けたＴＦＴ１８ａとＴＦＴ１８ｂにＴｉからなるソース信号線２４とＣｒからなるゲート信号線２５を配設することにより、図示しない外部接続のＩＣ回路からの信号を受けＴＦＴ１８ａ、１８ｂをＯＮ、ＯＦＦさせている。

【００１２】このような構成における本第１実施例の特徴は、１画素の画素電極を２つの副画素電極に分割し、それぞれの副画素電極にチャネル幅Ｗおよびチャネル長Ｌの異なるＴＦＴを設けること、即ち、充電能力の異なるＴＦＴ等のアクティブ素子を設けていることにある。ただし、本第１実施例は理解を深めるために最も簡単な例を開示したに過ぎず、１画素の分割数を必ずしも２分割とする必要は全くなく無限に可能であり効果も上がる。しかしながら、分割数が増加すればＴＦＴも増加することになり、これに比例して画素面積が小さくなるので、有効な分割数を十分考慮する必要がある。したがって、実用上好ましくは、１画素当たり２分割～５分割にすることが妥当である。また、分割後の副画素電極の面積についても本第１実施例のように１：１に固守する必要は全くなく、無限に構成可能である。

【００１３】次に本発明者らは、以上のような構成の液晶表示素子における視角特性を知るため、図３に示す液晶表示素子を図４に示す測定方法によりＶ－Ｔ特性を解析、評価した。図３は、面積比が１：１となるように画素電極を２分割した本第１実施例の液晶表示素子の斜視図であり、図示しないＴＦＴを形成したＴＦＴ基板２６と上偏光板２９をＴＦＴ基板ラビング方向２７と上偏光板吸光軸２８が一致するように貼り合わせ、また、フィルタを形成したフィルタ基板３０と下偏光板３３をフィルタ基板ラビング方向３１と下偏光板吸光軸３２が一致するように貼り合わせたことを示している。つまり、上偏光板２９と下偏光板３３はＮＷ（ノーマリホワイト）モード、即ち、電圧無印加状態で白表示となるように吸光軸をクロスさせて貼り合わせた液晶表示素子である。

【００１４】また、Ｖ－Ｔ特性の測定方法は図４に示す方法により実施した。即ち、液晶表示素子３４の上偏光板３５側から垂線上方向を正面とし、この正面方向からＶ－Ｔ特性を測定し始め、下方向（図のθ方向）に徐々に測定位置（図の矢印方向）を変化させることにより実施した。以上のような測定方法により得られた結果は次のようであった。

【００１５】まず第１に、図３の液晶表示素子を解析、評価するために、画素電極を分割せずかつＴＦＴが画素電極に対して十分に充電能力を有する場合、即ち、チャネル幅Ｗが大きくかつチャネル長Ｌが小さい場合の液晶表示素子（図示せず）のＶ－Ｔ特性について測定した。測定位置はθ＝０度（即ち、正面）、１０度、２０度、３０度、４０度、５０度とし、それぞれについて実測して得た結果を図５に示した。図５における横軸は画素電極への印加電圧であり、縦軸は正面（測定位置θ＝０度に相当）の最大透過率を１００％としたときの相対透過率である。図５によると、例えば、測定位置をθ＝５０度とした場合において特に顕著であるが、印加電圧が０Ｖから６Ｖまで徐々に増加するに従って、略１．５Ｖ付近から相対透過率は急激に減少し始め、略２．５Ｖ付近で一旦Ａ点（相対透過率、略１０％に相当）に達している。ところが、さらに印加電圧が増加すると相対透過率が増加する現象が現れ、略３．４Ｖ付近でＢ点（相対透過率、略１８％に相当）まで達し、その後印加電圧が増加するにつれ相対透過率は緩やかに減少している。このように、印加電圧が増加するにつれて相対透過率が一度減少してから増加して、さらに再度減少するという現象

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が、液晶表示素子の明るい表示と暗い表示の反転原因であり、下方向の視野角範囲が狭いと言われる所以である。

【００１６】ここで、本実施例においては、この現象を特に「ふくらみ現象」と呼ぶことにする。このようなふくらみ現象は、図５ではおおよそ測定位置がθ＝３０度から明らかに現れ始め、測定位置が下方向（即ち、θ＝４０度、５０度）になるに従って大きくなることが分かる。

$I_D = -\beta (V_D - V_S) \{2 (V_G - V_T) - (V_D + V_S)\}$

I_D：ドレイン電流、V_S：ソース電圧、V_G：ゲート電圧

V_T：ＴＦＴの閾値特性

【００１９】

【数２】$\beta = (W/L) C_i \mu / 2$

W：チャネル幅、Ｌ：チャネル長、C_i：単位面積当たりのゲート絶縁膜容量、μ：移動度

【００２０】

$$V_D = V_s - \frac{2 (V_G - V_T - V_s)(V_s - V_0) P}{2 (V_G - V_T - V_s) + (V_s + V_0)(1 - P)}$$

V_0：初期ドレイン電圧

【００２３】

【数６】

$P = \exp \{-(2\beta / C_t)(V_G - V_T - V_S) t\}$

ｔ：ゲートＯＮ時間

これらの数式１、２、３、４、５、６よりシュミレーションしたＶ－Ｔ特性結果を図６に示す。

【００２４】図６によると、印加電圧０Ｖ～６Ｖにおいて、測定位置がθ＝３０度および４０度ではふくらみ現象が殆ど無いことが分かる。また、θ＝５０度では、相対透過率は図５と同様に略１．５Ｖ付近から急激に減少し始めるが、略３．４Ｖ付近で一旦Ａ’点（相対透過率、略１０％に相当）に達し、略５．７Ｖ付近でＢ’点（相対透過率、略１８％に相当）まで達する若干のふくらみ現象が現れることが分かる。

【００２５】以上のような図５と図６の解析結果をもとに、特に代表として測定位置がθ＝５０度の場合について両者のＶ－Ｔ特性を図７に示し比較、検討を行った。これは、ＴＦＴの充電能力が画素電極に対して十分である場合と不十分である場合の比較、検討である。図７において、破線３６は画素電極への充電能力が十分な場合の図５に示したＶ－Ｔ特性であり、一点鎖線３７は画素電極への充電能力が不十分な場合の図６に示したＶ－Ｔ特性である。ここで破線３６のＡ点、Ｂ点（図５のＡ点、Ｂ点に相当）は、一点鎖線３７のＡ’点、Ｂ’点（図６のＡ’点、Ｂ’点に相当）に移動しているのが分かる。また、このような両者のＶ－Ｔ特性を混合すれば実線３８のようになり、ふくらみ現象が殆ど抑止されのが分かる。これは、図１のように１画素を２分割した副

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＊【００１７】これに対して第２に、ＴＦＴの充電能力が画素電極に対して不十分である場合、即ち、チャネル幅Ｗが小さくかつチャネル長Ｌが大きい場合のＶ－Ｔ特性について解析した。この場合のＶ－Ｔ特性は、図５の実測値および電気特性の一般式である数式１、２、３、４、５、６から容易に計算することができる。

【００１８】

【数１】

＊

※【数３】$I_D = C_t \, dV_D / dt$

【００２１】

【数４】$C_t = C_{LC} + C_S + C_{GD}$

C_{LC}：液晶容量、C_S：蓄積容量、C_{GD}：ゲート～ドレイン間容量

【００２２】

【数５】

※

【００２６】そこで第３に、上記解析結果を踏まえて、図１の構成の液晶表示素子のＶ－Ｔ特性が、異なる複数の測定位置において、実際に図７の実線３８のようになるか否かを確認するため、このＶ－Ｔ特性を実測し図８に示した。図８は、測定位置がθ＝３０度、４０度、５０度のときの本第１実施例のＶ－Ｔ特性であり、どの測定位置においてもふくらみ現象は確実に十分低減していることが分かる。

【００２７】以上のような構成、Ｖ－Ｔ特性の液晶表示素子にあっては、少なくとも視野角範囲が正面方向から下方向へθ＝５０度まではふくらみ現象が確実に抑えられるので、視角特性が十分満足のいく液晶表示素子が得られる。なお、本発明者らは同様のＶ－Ｔ特性解析により、ふくらみ現象が抑止可能な範囲としてθ＝６０度まで有効であることを確認した。

【００２８】また、画素電極上に余分に絶縁膜と付加コンデンサ電極を重畳形成するという複雑な構成を採る必要が全くないので、異物付着、成膜不良、点欠陥、および線欠陥不良等が増加することなく信頼性の高い液晶表示素子が得られる。なお、本第１実施例では、充電能力を有するアクティブ素子として１つの副画素電極あたり１つのＴＦＴを使用した場合について詳述したが、ＴＦＴは複数使用しても同様の効果は得られる。さらに、アクティブ素子としてＭＩＭ（Ｍｅｔａｌ－Ｉｎｓｕｌａｔｏｒ－Ｍｅｔａｌ）を用いても、全く同様の効果を得ることが可能である。

画素電極２３ａ、２３ｂに充電能力の異なるＴＦＴ１８ａ、１８ｂを設けて得られるＶ－Ｔ特性と同等のものとなるのである。

【００２９】また、本第１実施例では、ＮＷ（ノーマリホワイト）モードの液晶表示素子について詳述したが、ＮＢ（ノーマリブラック）モード、即ち、電圧無印加状態で黒表示を示すモードであっても、全く同様の効果を得ることが可能である。

（第２実施例）第１実施例ではＴＦＴを形成する透明基板での画素電極の分割について詳述したが、この画素電極に対向する他方の透明電極側であっても同様の効果が得られるので、以下図に従って説明する。

【００３０】図９は本第２実施例の液晶表示素子の要部平面図である。これは、ＴＦＴ４１を有する１画素の画素電極３９に対向する対向電極４０を、例えば互いに面積の異なる領域α、β、γを有する副対向電極４０ａ、４０ｂ、４０ｃの３つに分割して、それぞれに異なる電圧を印加することにより、第１実施例と全く同様の効果を得ようとするものである。

【００３１】図１０は図９のＢ－Ｂ断面図であるが、第１実施例の図２に示す液晶表示素子と同様な構成であるため説明は省略する。ただし、副対向電極４０ａ、４０ｂ、４０ｃの間からの漏光防止は、各間にブラックマスク４３を設けることで達成している。また、４４は下偏光板、４５は上偏光板、４６、４７は透明電極、４８は画素電極、４９はフィルタ、５０、５１は配向膜、５２は液晶層である。

【００３２】ここで、液晶層５２へ印加される実効電圧は副対向電極４０ａ、４０ｂ、４０ｃへの印加電圧とＴＦＴ４１を介してソース信号線４２から画素電極３９に供給される画素電圧の和となる。さて、このような構成の液晶表示素子のＶ－Ｔ特性を第１実施例と全く同様な測定方法により解析、評価を試みたので、以下図に従って説明する。

【００３３】まず第１に、副対向電極に分割する前の対向電極において、この対向電極への印加電圧を１．５Ｖとした場合のＶ－Ｔ特性について測定した。測定位置はθ＝０度（即ち、正面）、１０度、２０度、３０度、４０度、５０度とし、それぞれについて実測して得た結果を図１１に示した。なお、図１１における縦軸は正面での最大透過率を１００％としたときの相対透過率を示し、横軸は画素電圧を示す。図１１によると、ふくらみ現象は、第１実施例の図５と同様、おおよそ測定位置がθ＝３０度から現れ始め、測定位置が下方向（θ＝４０度、５０度）になるに従って大きくなることが分かる。

【００３４】これに対して第２に、副対向電極に分割する前の対向電極において、この対向電極への印加電圧を０．５Ｖ、１．０Ｖ、１．５Ｖとした場合のＶ－Ｔ特性を、特に代表として測定位置θ＝４０度について測定した結果を図１２に示す。図１２によると、対向電極への印加電圧が１．５ＶのＶ－Ｔ特性に比して０．５Ｖおよび１．０ＶのＶ－Ｔ特性は、印加電圧が小さい分０．５Ｖずつ図の右方向へ（ふくらみ現象が）シフトしていることが分かる。

【００３５】次に第３に、これらの結果を踏まえ、図９に示すような１画素の画素電極３９に対する対向電極４０を３つの副対向電極４０ａ、４０ｂ、４０ｃとする本第２実施例の場合のＶ－Ｔ特性を解析、評価し図１３に示した。このとき、副対向電極４０ａ、４０ｂ、４０ｃと画素電極３９がオーバーラップする領域をそれぞれ領域α、領域β、領域γとし、それぞれの領域の面積比を７％、２１％、７２％とした。そして、副対向電極４０ａ、４０ｂ、４０ｃにそれぞれ０．５Ｖ、１．０Ｖ、１．５Ｖの電圧を印加した。図１３によると、３つの領域α、β、γのＶ－Ｔ特性は、図１２と同様に、０．５Ｖずつ図の右方向へシフトし、さらに領域α、β、γの面積比が異なる分、画素電圧０Ｖにおける相対透過率も比例して異なっているのが分かる。ここで、画素電極３９の面積は領域α、β、γの面積の総和に等しいので、領域α、β、γの混合となる実線５３のようなＶ－Ｔ特性は、そのまま画素電極３９のＶ－Ｔ特性であるといえる。また、実線５３、即ち、画素電極３９のＶ－Ｔ特性は、図１１あるいは図１２に示すような測定位置θ＝４０度でのＶ－Ｔ特性に比して明らかにふくらみ現象が無くなっているのが分かる。

【００３６】そこで第４に、上記解析結果を踏まえて、図９の構成の液晶表示素子のＶ－Ｔ特性が、異なる複数の測定位置において、実際に図１３の実線５３のようになるか否かを確認するため、このＶ－Ｔ特性を実測し図１４に示した。図１４は、測定位置がθ＝０度（即ち、正面）、１０度、２０度、３０度、４０度、５０度とした場合での本第２実施例のＶ－Ｔ特性である。図１４によると、測定位置θを少なくとも正面から５０度まで変化させてもふくらみ現象が全く現れないことで、第１実施例と全く同様な効果が得られたことを確認した。なお、本発明者らは同様のＶ－Ｔ特性解析により、ふくらみ現象が抑止可能な範囲としてθ＝６０度まで有効であることを確認した。

【００３７】以上の結果により、１つの画素電極に対する対向電極を３つの副対向電極に分割する構成の液晶表示素子であっても、第１実施例と全く同様の効果が得られることになる。なお、本第２実施例では個々の画素電極に対向する対向電極を３つの副対向電極に分割した例を示したが、３分割に固守する必要はなく、複数の副対向電極に分割しそれぞれの副対向電極に異なる電圧を印加しても本第２実施例と全く同様の効果が得られることは言うまでもない。

【００３８】また、本第１実施例に示す構成と本第２実施例に示す構成との両方を混合しても全く問題ない。

【００３９】

【発明の効果】以上述べたように、本発明にあっては、請求項１において、個々の画素電極を複数の副画素電極に分割しこの副画素電極に充電能力の異なるアクティブ

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素子を設けたので、絶縁膜と付加コンデンサ電極を余分に重畳形成することなく、液晶表示素子の視角特性を向上させることができるという優れた効果を奏する。

【００４０】また、請求項２において、対向電極を面積比の異なる領域を有する複数の副対向電極に分割しそれぞれの副対向電極に異なる電圧を印加したので、前記と同様の優れた効果を奏する。さらに、請求項３において、請求項１と請求項２記載の本発明を併合したので、前記と同様の優れた効果が得られる。

【図面の簡単な説明】

【図１】本発明の副画素電極を設けた透明基板の一画素を示す要部平面部である。

【図２】図１のＡ－Ａ断面図である。

【図３】本発明の液晶表示素子の斜視図である。

【図４】本発明のＶ－Ｔ特性の測定方法を示す。

【図５】画素電極を分割せず、かつＴＦＴの充電能力が十分な液晶表示素子のＶ－Ｔ特性を示す。

【図６】画素電極を分割せず、かつＴＦＴの充電能力が不十分な液晶表示素子のＶ－Ｔ特性を示す。

【図７】測定位置がθ＝５０度の場合のＶ－Ｔ特性を示す。

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【図８】本発明の異なる測定位置でのＶ－Ｔ特性を示す。

【図９】本発明の他の実施例の液晶表示素子の要部平面を示す。

【図１０】図９のＢ－Ｂ断面図である。

【図１１】副対向電極に分割する前の対向電極の、異なる測定位置でのＶ－Ｔ特性を示す。

【図１２】副対向電極に分割する前の対向電極の、測定位置θ＝４０度でのＶ－Ｔ特性を示す。

【図１３】本発明の他の実施例の３つの領域におけるＶ－Ｔ特性を示す。

【図１４】本発明の他の実施例の異なる測定位置でのＶ－Ｔ特性を示す。

【符号の説明】

９、３９、４８　画素電極

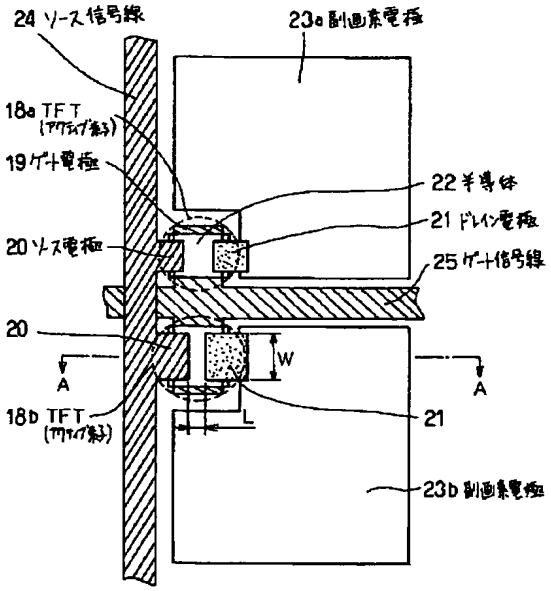
１８ａ、１８ｂ、４１　ＴＦＴ（アクティブ素子）

２３ａ、２３ｂ　副画素電極

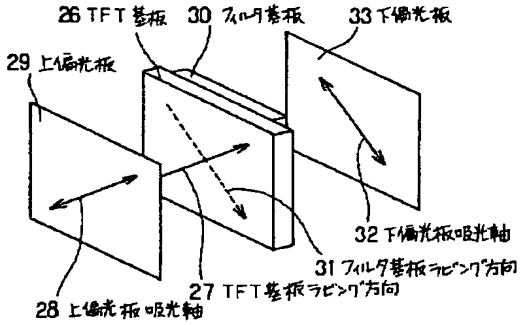
１６、４０　対向電極

４０ａ、４０ｂ、４０ｃ　副対向電極

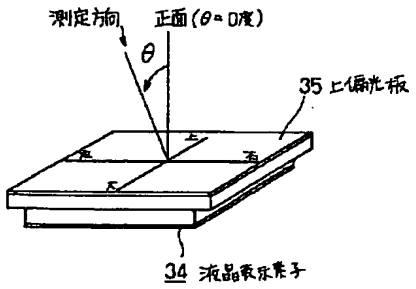
【図１】



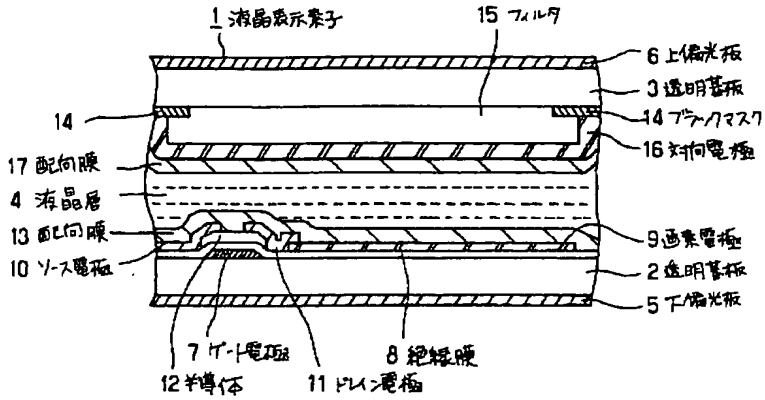
【図３】



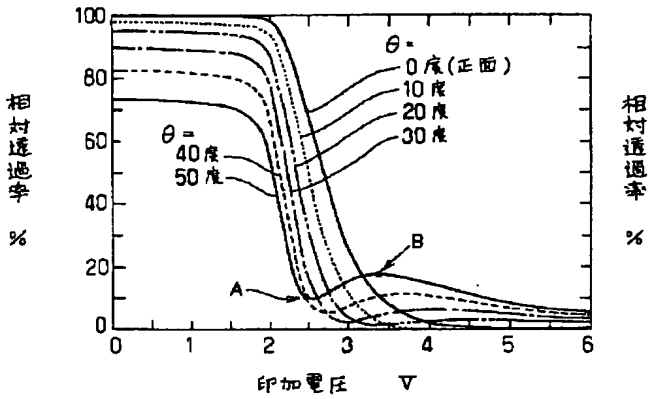
【図４】



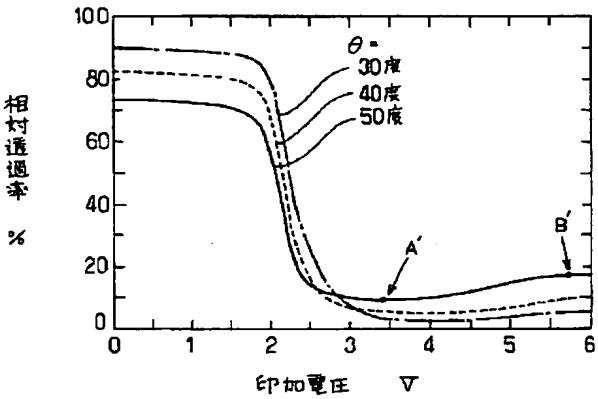
【図２】


1 液晶表示素子
15 フィルタ
6 上偏光板
3 透明基板
14
14 ブラックマスク
16 対向電極
17 配向膜
4 液晶層
13 配向膜
9 画素電極
10 ソース電極
2 透明基板
5 下偏光板
7 ゲート電極
8 絶縁膜
12 半導体
11 ドレイン電極

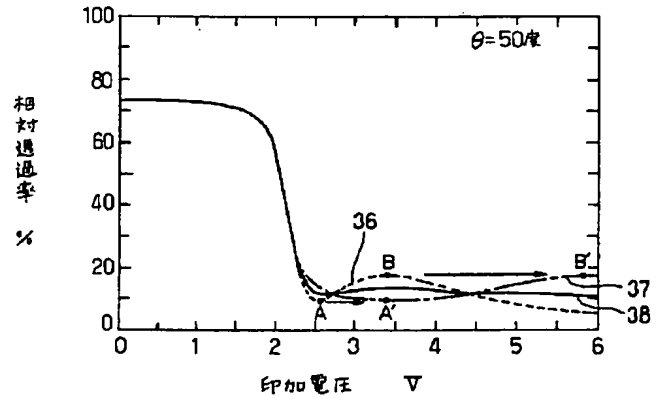
【図５】


相対透過率 %
θ=
0度(正面)
10度
20度
30度
θ=
40度
50度
A
B
印加電圧 V

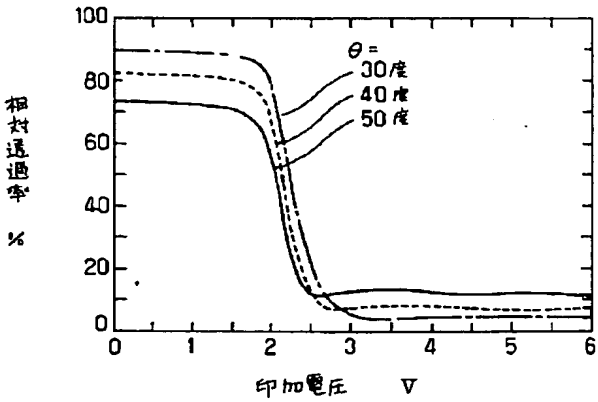
【図６】


相対透過率 %
θ=
30度
40度
50度
A'
B'
印加電圧 V

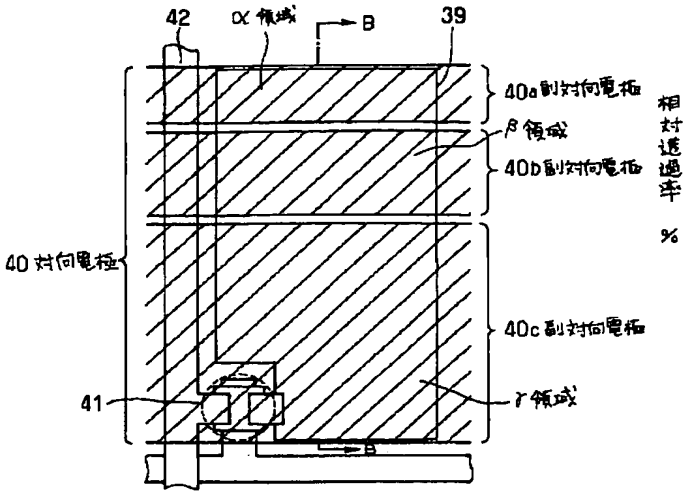
【図７】


相対透過率 %
θ=50度
36
A
A'
B
B'
37
38
印加電圧 V

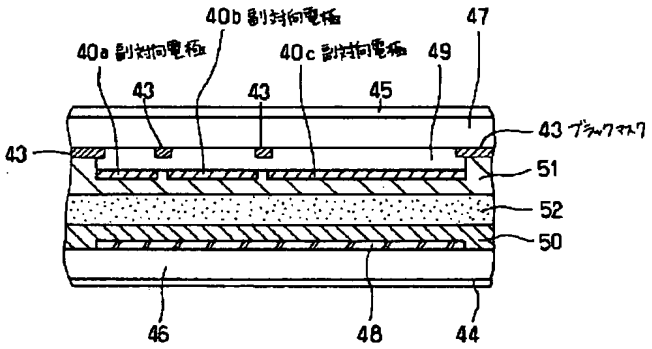
【図８】


相対透過率 %
θ=
30度
40度
50度
印加電圧 V

【図９】



【図１０】



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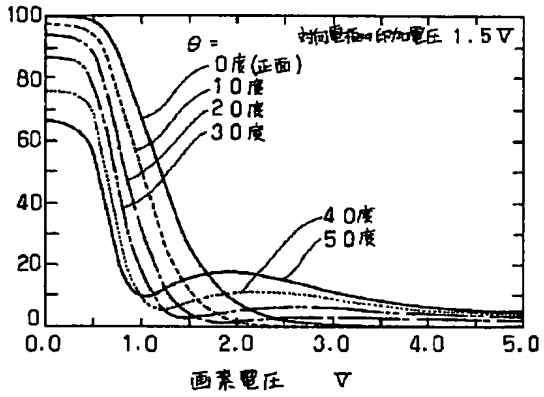

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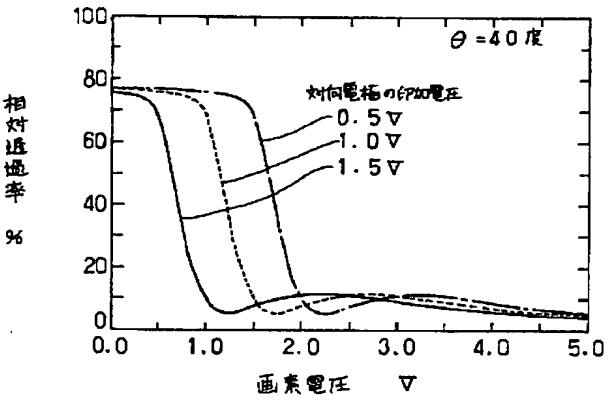

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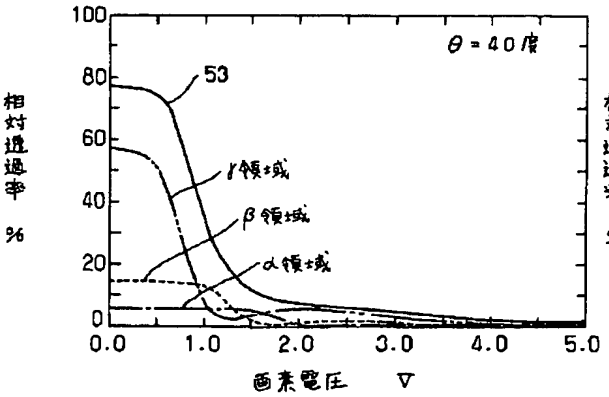

【図１４】